

A Truly Remarkable Man

The world has lost a great geologist and geochemist, and a great Canadian who had contributed to his country for over 60 years. On Monday, August 5th, 2003, Robert William Boyle left this world peacefully after a long struggle with illness, and a much longer struggle with failing eyesight. The latter had not curbed his determination to finish his most recent scientific endeavour, his 'History of Cosmochemistry and Geochemistry', which is being considered for publication by the McGill-Queen's University Press. He completed the last editorial work on the Preface the day before his death with assistance from his daughter-in-law Christy Vodden.

Bob, born June 3rd 1920, grew up near Wallaceburg in southwestern Ontario. It was there that he developed his interest and love for the natural world. As a teenager he learned to trap, and saved his earnings from muskrat and mink pelts for his future education. Even from those early days Bob was intrigued with chemistry, and had his own laboratory in the attic of the family farm. It was his friendship with James McCrae, a 70-year-old retired prospector, living two farms away that was critical. One can imagine the impression that the stories of prospecting in Northern Ontario had on the teenager who loved the outdoors. During his last two summers at Wallaceburg High School he decided to earn the money that would enable him go to university and study geology. With contacts from McCrae he joined a prospecting syndicate in northern Ontario, where he started at the bottom - cutting line, and as a driller's helper.

Europe went to war in September 1939, and Bob enlisted in the Royal Canadian Artillery two days before Canada joined the war. He used to tell the story of how two Military Policemen arrived at the farm later to collect the 'errant son' for not reporting for conscription. His mother Jeannie sent them away with a tongue lashing and a copy of Bob's regimental address in England! He spent most of the next six years in the European theatre, where he served with distinction. Initially stationed near Hastings in Sussex, England, as part of the defence of the southern coast, he then took part in the landing in Normandy in 1944 and advanced through France, Belgium, Holland into northwest Germany. Notwithstanding his military service, Bob still made time for geology. While stationed in England, he took geology courses at Imperial College, and correspondence courses from Queen's University, Kingston. It was at Imperial College that he met Professor H.H. Read of Donegal Granite fame. One has to wonder if seeds were not sown there that later grew to fruition in Bob's ideas concerning 'lateral secretion'. Perhaps not out of character, Bob refused a commission and remained a NCO, being discharged on October 26th, 1945, with the rank of lance-sergeant.

Just eight days later on November 3rd Bob married his childhood sweetheart, Marguerite Brown, who had grown up on a neighbouring Wallaceburg farm. On his honeymoon, it is told, he spent time studying physics for his university admissions test. In January 1946, Bob enrolled in Geology at the University of Toronto as part of an accelerated program available for returning servicemen. In the summer of 1947 he worked underground for Madsen Red Lake Gold Mines. He graduated with a degree in Mining Geology in 1949, his Bachelor's dissertation was on

sediments of the Yellowknife Supergroup, based on his work as a summer field assistant for the Geological Survey of Canada (GSC) in 1948. The following year he was again a field assistant for the GSC and J.F. (Fen) Henderson and I.C. Brown in their Yellowknife, NWT, mapping project. In the Fall Bob immediately commenced graduate work at Toronto on the Yellowknife gold deposits, completing his M.A.Sc. in 1950. Through his field mapping with Fen Henderson and graduate work, his potential was recognized by the GSC, and in 1952 he joined as a permanent member of staff. He completed and successfully defended his Doctoral thesis in 1953, subsequently published by the GSC as Memoir 310, 'Geology, Geochemistry, and Origin of the Gold Deposits of the Yellowknife District, Northwest Territories', in 1961. It was during his graduate research on the sediments and shear zones at Yellowknife that Bob developed his ideas on 'lateral secretion' as an ore-forming process, and one of the causes of primary geochemical halos surrounding mineral deposits that could be used as guides to their presence.

Bob was a pioneer of the application of geochemistry to mining geology and mineral exploration. In 1955 he persuaded the GSC to provide space for a 'laboratory for geochemical prospecting studies'. This facility was expanded to a full laboratory in 1957, when he hired Peggy Gilbert and Ron Holman, who were working with John Webb at his Geochemical Prospecting Research Centre at Imperial College, London, and Eion Cameron to broaden the group's interests into sedimentary litho-geochemistry. Also in 1957 the GSC's regional geochemistry program commenced with Boyle and Holman's work in Nova Scotia. In 1961 the GSC moved to a new building with new laboratories at its present Ottawa site on Booth Street. With the support of enlightened senior management conscious of the need to bring hard science into geology, Bob designed these geochemistry laboratories to meet the needs of mineral exploration rather than those of traditional petrochemistry, and hired permanent staff, post-doctoral fellows and students, to undertake field and laboratory studies. Over the years, these included Bob Washington, Art Smith, Adrian Debnam, Chris Durham, John Lynch, Willy Dyck, Chris Gleeson, Don Sangster, John Fortescue, Les Davies, Walter Nash, Mohammed Tauchid and Bob Garrett, names familiar in exploration geochemistry and mineral exploration. Bob stood down from leading the 'Geochemistry Section' in 1967 to concentrate on his beloved precious metals, and to write up his voluminous research and observations. Those who visited his office on the 7th Floor at Booth Street will remember the filing card cabinets stacked to the ceiling. Bob had amassed the card predecessor of GeoRef, his key to bibliographic knowledge.

His work at the GSC in the 1950s and 1960s took him to Yellowknife, NWT; the lead-zinc-silver deposits of Keno Hill, Yukon; the barite deposit at Walton, Nova Scotia; the Bathurst, New Brunswick, base-metal camp; and the Cobalt, Ontario, silver-cobalt deposits. Bob's studies led to new insights on the formation of these ore deposits and the development of geochemical methods to aid mineral exploration. When Bob first started work at Walton it was known as a barite deposit. His work led to the discovery of the underlying blind base-metal zone that was subsequently brought into production. How did he come to suspect its presence? He noted high zinc in the spring waters surfacing in the open-pit, and recommended to the mining company that they drill deeper. Similarly, his observations on metalliferous groundwaters at Cobalt contributed to the development of the rich Silverfields deposit. It was around the time he was

working in Nova Scotia and New Brunswick that he became fascinated with the ability of bogs to sequester metals such as Cu, Pb, Sb and Au from groundwaters. The result was that many concoctions were 'brewed' in large beakers on window sills in the 7th floor geochemistry labs on Booth Street, and experimental work undertaken to see just how much gold was taken up by humic acids. That was when Bob won for himself the sobriquet of 'Boggy Bob', which stuck with him as closely as gold does to humates for the rest of his days. With respect to the North and permafrost regions, it was Bob's work at Yellowknife and, in particular, at Keno Hill, that demonstrated that geochemical prospecting did work, and that trace elements were dispersed hydromorphically in permafrost regions. Simultaneously Russian geochemists were reaching the same conclusions, confirmed by Bob's National Research Council exchange-visit to the Soviet Union in 1962. One of his favourite lines of evidence that metals were mobile in sub-Arctic environments, were dendritic gold, silver and zinc metal precipitates that he had collected from ice-veins in the Yellowknife and Keno Hill deposits. It was the research he undertook at Keno Hill that guided the development of geochemical prospecting tools ensuring that a 'dying mining camp' continued in production some 30 more years until the 1980s.

Bob's interest in gold, silver, uranium and thorium took him to many parts of the world: the USA, the USSR, Finland, Norway, Sweden, Great Britain, Eire, France, Greece, Bulgaria, Fiji, Australia, New Zealand, Japan, China, India, many countries in Africa, and Brazil. He put together some of his best known publications based on his global observations and knowledge: 'The Geochemistry of Silver and its Deposits' (GSC Bulletin 160, 1968); 'Elemental Associations and Indicators of Interest in Geochemical Prospecting' (GSC Paper 68-58, revised as Paper 74-45); 'The Geochemistry of Gold and its Deposits' (GSC Bulletin 280, 1979); and 'Geochemical Prospecting for Thorium and Uranium Deposits' (IAEA, Vienna, 1981). It is not really appropriate to single out these publications; his contributions were many. Bob was a prolific writer, and during his career published over 160 papers, books and articles. He thought about what he was going to write extensively and thoroughly before he put down his words. At the GSC the quality of his first drafts was legendary. He believed writing should be clear and concise, as he said, 'like a Scotsman sending a telegram'.

In the 1970s, as government and public interests in environmental issues came to the fore, Bob and Ian Jonasson co-authored a series of reports commissioned by the National Research Council of Canada on trace element cycles and abundances in the natural environment. These stressed the importance of geology, mineralogy and geochemistry in understanding the sources, transport and sinks of these elements. The reports have stood the test of time and are still extensively referred to as basic source material in environmental risk assessments.

Bob was interested in history and archeology, and was widely read. Many of his publications included references and anecdotes concerning the history of mining and mineral exploration back to the times of early civilizations in Europe and Asia. It was his interest in history that drove many of his later writings following his retirement from the GSC in 1985: for example, 'Gold: History and genesis of deposits' published by the Society of Economic Geologists in 1987. The truth of the matter is that Bob never retired from his love of geochemistry, as evidenced by his

commitment to completing his last book just prior to his death

Bob was a committed family man. One of the joys of the family were summer holidays spent together at places across Canada where Bob was undertaking field work - a luxury for geologists, who are so often in the field during their children's holidays. His children, Heather and Dan, followed him into science, Heather as a biochemist (Carleton and Victoria University of Wellington, NZ) and Dan as a geochemist (Queen's and Imperial College, UK). Although he spoke of it rarely, the loss of Dan, who followed his father to a distinguished career in the GSC, to cancer in 2000, was a grievous blow. Outside the family and work, his love for his vegetable garden was well known to his colleagues, who benefited from the surplus in good harvest years. This love did not extend to farming; he had seen enough of the difficulties of the 1930s to leave bitter memories.

During Bob's career he contributed in many ways to his profession and received recognition for his service. He was elected to the Royal Society of Canada in 1957, astonishingly only four years after obtaining his doctorate, and received the Willett G. Miller Medal for outstanding research in the earth sciences in 1971. The Miller Medal citation stated, "one of Canada's leading exploration geochemists, who has made fundamental advances in the study of the deposition of ores, the dispersion of elements around ore bodies, and the formulation of new methods in the search for natural resources. He has won an international reputation for his many contributions to our knowledge of the distribution of metals in the earth's crust, the concentration of these metals in nature as orebodies, and the successful application of geochemistry to the search for hidden ores." Words as true today as they were 30 years ago, and he did not let up in later years. He was elected a Fellow of the Royal Canadian Geographical Society in 1955. His contributions to the minerals industry were recognized by the Prospectors and Developers Association with their Distinguished Service Award in 1993, and induction into the Canadian Mining Hall of Fame in 1997. This is located at the University of Toronto's (his *Alma Mater*) Mining Building, and in today's connected world exists globally as <http://www.halloffame.mining.ca>. Similarly, he was recognized by the Canadian Institute of Mining, Metallurgy and Petroleum (CIM) with their Barlow Medal in 1966 (with John Jambor), and again in 1983, for outstanding publications in the CIM Bulletin. He was further elected a CIM Fellow in 1993, and in 2002 was awarded their Distinguished Service Medal. This was the same year that Dan posthumously received the Julian Boldy Memorial Award, a singular distinction in that it was the first time two members of the same family received awards in the same year. Bob's contributions to the geology and geochemistry of the Bathurst mining camp were recognized by the local geological community with a Service Award at the 1993 CIM Geological Field Conference held in Bathurst. The penultimate publication to bear Bob's name, as co-author with Steve McCutcheon and Bill Luff concerned Bathurst, 'The Bathurst Mining Camp, New Brunswick, Canada: History of discovery and evolution of geological models', to be published in Economic Geology Monograph 11, 'Massive sulphide deposits of the Bathurst Mining Camp, New Brunswick, and Northern Maine'.

Bob took on responsibilities with the professional societies that supported the science to which

he was committed: the Geological Association of Canada (GAC), the Society of Economic Geologists (Councillor, 1981-1985), and the International Association for the Genesis of Ore Deposits (IAGOD). He was a founding member of IAGOD at St. Andrew's University, Scotland, in 1966, its first Treasurer, Vice-President (1978-1989), President (1989-1992) and Chairman of the Organizing Committee for the 8th IAGOD Symposium in Ottawa, June, 1990. That year he was also made an Honorary Professor of the University of Earth Sciences, Changchun, China. In 1971 he received the Public Service of Canada Merit Award for his contributions to science in the federal government. His abilities as an editor, along with his co-editors, were recognized by the Society of Technical Communicators' 1991 Award of Excellence for editing 'Sediment-hosted Stratiform Copper Deposits' published by the GAC. In 1992 his long years of service to the Mineralogical Association of Canada were recognized by the award of their Past President's Medal. In 1999 he was made an Honorary Life Member of IAGOD - a rare honour that recognized an outstanding life-time commitment to the geology and geochemistry of ore deposits.

In 1966, driven by his desire to foster the development of geochemical prospecting, Bob organized at the GSC the first of a series of meetings (see GSC Paper 66-54) that were to develop into the biennial International Geochemical Exploration Symposia (IGES). In 1970 he was Chairman of the 3rd IGES in Toronto. It was at that meeting that the Association of Exploration Geochemists (AEG) was founded, and he took an active role in its early years as a member of its first Council (1970-1973), Vice-President (1973-1975) and President (1976). His significant contributions to exploration geochemistry were recognized by the AEG with his election to Honorary Membership in 1989. He was awarded the Association's Gold Medal in 1999 at the 19th IGES in Vancouver, BC, 33 years after the first meeting of the continuing series he founded. The citation stated, "in recognition of his lifetime of outstanding achievement in exploration geochemistry, during which, through his leadership and productivity, he played a key role in developing the science in Canada, advancing our knowledge of precious metals, applying geochemistry to mineral exploration and to environmental issues in Canada and around the globe, establishing exploration geochemistry at the Geological Survey of Canada, and training young geochemists."

Bob's commitment to training and teaching came through in many ways. The students hired into the GSC for summer field and laboratory work who worked with Bob were exposed to geochemical prospecting, which later became known as exploration geochemistry, and his own enthusiasm. Importantly, Bob inspired many of these students to pursue careers in geochemistry and mineral deposit studies. One such occasion was when he visited the Lakehead, Ontario, while working on his 'Silver Bulletin'. He met Jim Franklin, a future Chief Geoscientist at the GSC, as a student and took time to guide him around the Sibley silver deposits that became the subject of Franklin's graduate thesis. This was just one of many examples of Bob's willingness to help students. He was a Special Lecturer in Geochemistry at Carleton University, Ottawa, from 1955 to 1975. As part of his Carleton responsibilities he taught a Prospecting Course, and one is tempted to draw the parallel to his exposure to the old prospector James McCrae in Wallaceburg in the 1930s, and how Bob would have given 'new prospectors' an enthusiasm for the search for

precious metals.

More formally, he was a constant proponent of exploration geochemistry and was one of its best known ambassadors, either as a visiting lecturer or a consultant to UNESCO, UNDP and the World Bank. He was a Regional Lecturer for the CIM in 1966, 1968 and 1973, and their Distinguished Lecturer for 1980-81; a Senior Lecturer at the International Atomic Energy Agency (1975); and Visiting Lecturer at Jadavpur University, Calcutta, India (1981), and at Escola de Engenharia, Porto Alegre, Brazil (1985).

Bob's connection to precious metals continued to the very last, he died on almost the 100th Anniversary of the discovery of silver at Cobalt, Ontario, August 7th, 1903, <http://www.nt.net/cobalt/minemus.htm>.

On a personal note, Bob was a wonderful person. He could always add something interesting and provoking to a discussion, he was a superb raconteur, and always generous with his time and his friendship, especially to younger scientists. We have lost a truly remarkable man, and those lucky enough to have met him, known and worked with him, will not forget.

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